

Open Research Online

The Open University's repository of research publications and other research outputs

Scaffolding Reflection: Prompting Social Constructive Metacognitive Activity in Non-Formal Learning

Journal Item

How to cite:

Farrell Frey, Tracie; Iwa, Karolina and Mikroyannidis, Alexander (2017). Scaffolding Reflection: Prompting Social Constructive Metacognitive Activity in Non-Formal Learning. *International Journal of Technology Enhanced Learning*, 9(4) pp. 277–306.

For guidance on citations see [FAQs](#).

© 2017 Inderscience Enterprises Ltd.



<https://creativecommons.org/licenses/by-nc-nd/4.0/>

Version: Accepted Manuscript

Link(s) to article on publisher's website:
<http://dx.doi.org/doi:10.1504/IJTEL.2017.10004360>

Copyright and Moral Rights for the articles on this site are retained by the individual authors and/or other copyright owners. For more information on Open Research Online's data [policy](#) on reuse of materials please consult the policies page.

oro.open.ac.uk

Scaffolding reflection: prompting social constructive metacognitive activity in non-formal learning

Tracie Farrell Frey*

Knowledge Media Institute,
The Open University,
Walton Hall, MK76AA Milton Keynes, UK
Email: tracie.farrell-frey@open.ac.uk
*Corresponding author

Karolina Iwa

Progressive Partners
ul. Sarmacka 10A/10, 02-972 Warsaw, Poland
Email: karolina.iwa@progressivepartners.pl

Alexander Mikroyannidis

Knowledge Media Institute,
The Open University,
Walton Hall, MK76AA Milton Keynes, UK
Email: alexander.mikroyannidis@open.ac.uk

Abstract: The study explores the effects of three different types of non-adaptive, metacognitive scaffolding on social, constructive metacognitive activity and reflection in groups of non-formal learners. Six triads of non-formal learners were assigned randomly to one of the three scaffolding conditions: structuring, problematising or epistemological. The triads were then asked to collaboratively resolve an ill-structured problem and record their deliberations. Evidence from think-aloud protocols was analysed using conversational and discourse analysis. Findings indicate that epistemological scaffolds produced more social, constructive metacognitive activity than either of the two other scaffolding conditions in all metacognitive activities except for task orientation, as well as higher quality interactions during evaluation and reflection phases. However, participants appeared to be less aware of their activities as forming a strategic, self-regulatory response to the problem. This may indicate that for learning transfer, it may be necessary to employ an adaptive, facilitated reflection on learners' activities.

Keywords: epistemic cognition; epistemology; ill-structured problems; intragroup metacognition; metacognitive prompts; non-formal learning; reflection; scaffolding metacognition; self-regulated learning; social constructive metacognition.

Reference to this paper should be made as follows: Frey, T.F., Iwa, K. and Mikroyannidis, A. (201X) 'Scaffolding reflection: prompting social constructive metacognitive activity in non-formal learning', *Int. J. Technology Enhanced Learning*, Vol. XX, No. YY, pp.XXX–XXX.

Biographical notes: Tracie Farrell Frey is a PhD student at the Knowledge Media Institute of the Open University UK. Her research interests are social and self-regulated learning, technology-enhanced learning and, more specifically, metacognition in learners.

Karolina Iwa is an Organisational Psychologist and Facilitator at Progressive Partners and track2, with a focus on self-organisation and collaborative learning processes.

Alexander Mikroyannidis is Research Associate at the Knowledge Media Institute. His research areas include self-regulated learning, personalised learning, inquiry-based learning, open educational resources and rich interactive learning materials.

1 Introduction

Educational reformer John Dewey proposed a definition of reflection as a *mechanism for learning in which interpretations are formed and tested through a deliberate and structured process*. Dewey felt that this process required the participation of a community that could validate or question interpretations and which was comprised of individuals who valued the ‘personal and intellectual’ growth that could be won through this process (Rodgers, 2002, p.845). Reflection, by this definition, is a powerful tool, a gateway to all higher ordered thinking, which is concrete, social and emotional in nature. This is as true for online learning, as it is for learning offline (Huang, 2002). Creating environments conducive to reflection, therefore, is a complex and strategic process. This is especially challenging when an instructor has less access to some of the more social and emotional aspects of learning (as is the case with blended and online learning environments). Researchers and practitioners who are engaged with the subject of reflection in online learning must examine reflection in terms of the practical aspects of where, what and how to reflect with learners, but also the need for exchange and dialogue as part of the reflexive process as well as the affective and personal characteristics that fuel reflexive discourse. To generate cohesive arguments around each of these elements, it is necessary to identify a specific context for reflection, along with associated goals, which can be attached to the learning object.

Studying reflection in non-formal learning environments presents some additional challenges. For non-formal learners, the goal may not always be domain knowledge acquisition (which can be formally assessed), but also personal development and more general learning skills, which develop over time (Huang, 2002). Likewise, the pedagogical intent and the learning object itself may be more general, in comparison with formal learning, such as ‘learning to learn’. To address this difficulty, the study described in this paper adopts a mixed-methods approach to exploring how to scaffold reflection within the educational framework of self-regulated learning.

Self-regulated learning is broadly defined in the research literature as a set of metacognitive processes by which learners plan, monitor, evaluate and exhibit control over their thinking, motivation, behaviour and educational context, in order to influence and improve learning outcomes (Pintrich, 2004; Zimmerman, 1990). In online learning, self-regulation is positioned as one of the most transferable learning skills, representing the full tool-kit of necessary competencies for understanding and controlling learning in

both formal and non-formal online environments (Van den Boom et al., 2004; McLoughlin and Lee, 2007; Dabbagh and Kitsantas, 2012). However, particularly in vocational education and other non-formal learning scenarios, research indicates that many people do not understand how to regulate their learning without the structure and external facilitation that formal, face-to-face learning can provide (McKinnon and Margaryan, 2009; Siadaty et al., 2012). This is particularly important, as a significant majority of research on self-regulated learning has been (and continues to be) conducted in formal learning environments, which do not represent the majority of learning experiences with which individuals are likely to be confronted (Fontana et al., 2015; Siadaty, Gašević and Hatala, 2016). This paper contributes to the emerging body of research in the area of self-regulated learning in non-formal environments (Fontana et al., 2015; Littlejohn, Milligan and Margaryan, 2012).

More specifically, this paper describes the effects of three different types of non-adaptive, metacognitive scaffolding on social, constructive metacognitive activity in groups of non-formal learners. In particular, we were interested in how the scaffolds provided impacted participants' ability to perceive and understand their learning strategies for self-regulation in relation to the task given to them. In addition, we hoped to uncover evidence for how metacognitive scaffolding can support collaborative processes during the various phases of regulated learning (orientation, planning, monitoring, evaluation and reflection) (Zimmerman, 1990; Pintrich and De Groot, 1990; Zimmerman and Schunk, 2011), with a focus on evaluative and reflexive processes. As we move towards pedagogical automation (Goggins et al., 2015) and the delivery of micro-content delivery (McLoughlin and Lee, 2007; Bruck, Motiwalla and Foerster, 2012) in technology-enhanced learning, a closer investigation of how learners make use of these resources for their learning is timely and warranted. Non-adaptive scaffolds, for this study, refer to fixed question prompts (Azevedo et al., 2005) that were provided to participants to simulate the online environment in which learning resources tend to be less dynamic (for example, in a Massive Open Online Course, or MOOC). To mirror a 'real-world' scenario more commonly found in non-formal learning, participants were asked to collaborate on resolving an ill-defined problem, defined as a problem with no formalised solution (Simon, 1977; Ge and Land, 2003; Lynch et al., 2006). In the paragraphs below, we present our arguments for the importance of examining reflection within this context, a description of our study, as well as a discussion on our findings and their resultant implications for current and future research.

2 Background

2.1 Socially shared regulated learning and metacognition in reflection

Reflection is an important mechanism through which learners *develop* their skills in self-regulated learning (Boekaerts, 1999; Sobral, 2000; Van den Boom et al., 2004). Whilst the name 'self-regulated learning' implies individual agency in the learning process, this does not mean that learners obtain these skills solely on their own. Hadwin, Järvelä and Miller (2011) have described the shift in constructivist perspectives on self-regulated learning from the 'individual' towards the 'social'. In particular, they discuss the ways in which individual learners benefit from being exposed to learning strategies presented to them by both instructors and peers (co-regulated and socially shared regulated learning,

respectively). Through reflection, metacognitive awareness arising from social exchanges that are local to a specific task or activity can be mobilised for future application. Educators can help to scaffold both individual collaborative processes of regulated learning by triggering targeted metacognitive actions that refer to the various phases and areas of self-regulation. Whilst it is clear that solitary learning is not sufficient for most learners to develop strong skills in self-regulation (Winne, 1995; Kravcik and Klamma, 2012), the quality of social interaction is what determines the extent to which learners can mobilise such interactions for their own learning (Molenaar, Sleegers and van Boxtel, 2014).

Reflection can significantly affect learners' abilities to make sense of how their own ideas, motivations, activities and contexts impact their educational outcomes. However, reflexive action can be extraordinarily difficult, especially when learners have deeply ingrained habits or beliefs about their learning that have gone unchallenged (Tough, 1979; Mezirow, 1990). As mentioned above, one of the ways in which learners can assess and reconsider their educational beliefs and metacognitive knowledge of their own learning experiences is through collaborative learning (Hadwin, Järvelä and Miller, 2011; Järvelä and Hadwin, 2013; Molenaar, Sleegers and van Boxtel, 2014). Collaborative learning can assist learners who are having difficulty by making it possible for them to witness effective strategies modelled by more successful peers, discuss and compare the merits of some strategies over others and provide learners with the interactive support that one solitary instructor cannot provide. Collaborative learning also can make it possible for learners to *co-construct* metacognitive knowledge, knowledge of which no individual member of the group is the sole author (Molenaar, Van Boxtel and Sleegers, 2010; Molenaar, Sleegers and van Boxtel, 2014). In essence, co-constructed metacognitive knowledge is that which was previously unknown to all members of the group, but which becomes known through iterative and cumulative efforts in thinking, acting and reflecting in learning. Molenaar et al. (ibid) found that the presence of co-constructed metacognitive activity was positively correlated to improved learning outcomes. As such, the study presented in this paper utilises the presence of quality, social, constructive metacognitive activity as both a support structure for reflexive action and as an indicator of learning.

2.2 Metacognition and self-regulated learning in non-formal environments

Using metacognition as a measure of learning impact has an important function for the present study. The specific context of this study is self-regulation in non-formal learning. In non-formal learning, the object of learning may not be necessarily outlined clearly in the design of the learning experience (Siadat, Gašević and Hatala, 2016) and may not include the aim of passing on formal qualifications or certification to learners (Colardyn and Bjørnåvold, 2004). Rather, individual learners often distil their own learning from the experiences that are presented to them within a given learning environment. For this to occur, learners must have the ability to perceive their own learning goals, the strategies that they have utilised to achieve those goals, and the mechanisms by which they can evaluate their achievement. However, non-formal learners do not always perceive themselves as learning entities, as they would in a formal learning environment (Wesiak et al., 2014), which frustrates the investigation of metacognitive awareness in such settings. In the case of the present study, self-regulated learning provides a framework

within which to establish measurements of learning to learn, for both learners and instructors (or researchers).

Investigations of non-formal learning also have implications for understanding professional learning and real-world problem-solving. The importance of this cannot be emphasised enough, as research has illustrated that learners have difficulty transferring more formally acquired skills across different domains (Ge and Land, 2003; Buckingham Shum and Deakin Crick, 2012). This may be partially due to what has already been established above about non-formal learners' identity as *learners*. Moreover, non-formal learning is ubiquitous. We are engaged in it every day. Studies have indicated that professionals learn significantly more through non-formal and informal means than through formal learning activities (Knight, Tait and Yorke, 2006). Thus, exploring the making of meaning inside of these learning environments, and the reflexive activity that helps to form and reform interpretations is paramount in understanding how most learning takes place. Identifying mechanisms for supporting reflexive thought in non-formal learning environments is part of that exploration.

2.3 Metacognition and reflection with ill-structured problems

The learning experience with which participants in this study were presented was to negotiate a solution to an ill-structured (ill-defined) problem. Marvin Minsky described an ill-structured problem as lacking in a 'systematic way to determine when a proposed solution is acceptable' (Lynch et al., 2006). The only way to resolve an ill-structured problem, therefore, is by imposing structure on the problem through defining a solution state, setting the parameters for recognising when that state has been achieved (as well as intermediary states) and developing operations for shifting between those states (Simon, 1977). The difference between a good solution and a poor solution to ill-structured problems, therefore, can be seen in how carefully and reproducibly participants attempt to bring order to the problem. For the study presented in this paper, we were able to use the participants' deliberations as a way of measuring the extent to which the groups were able to achieve this goal.

Professional and real-world learning contexts are awash with ill-structured problems, making them a priority in understanding learning transfer (Ge and Land, 2003). Ill-structured problems (and ill-structured domains) present a challenge for human learners in that it may be possible to arrive at many different solutions, depending on the information available to the problem solver(s) through their own experience, beliefs and mental constructs. For self-regulated learning inside of ill-structured problems, a learner must develop the capacity for recognising how certain mechanisms for structuring an ill-structured problem impact the result. Reflection, as mentioned previously, is where conscious learning transfer about such evaluations takes place. However, as the description of the problem itself and its solution can be perceived and interpreted quite differently by different individuals, the mechanism by which the problem solver should reflect on their interpretations must also mirror this subjective character (Boud, Keogh and Walker, 2013). This means, from the theoretical perspectives of personal construct theory and critical pedagogy, that it is important to create mechanisms for reflection that can be primarily driven by the learner (Boud, Keogh and Walker, 2013). For this reason, we chose to examine reflection that is not explicitly facilitated by an external person, but by learners themselves, using a set of predefined, non-adaptive prompts as a guide.

Research on learning transfer points to a lack in metacognitive activity as being responsible for learners' difficulty in applying what they have learned from domain to domain (Ge and Land, 2003). As such, one goal or *purpose* of reflection should be to leverage and improve metacognitive activity. The *product* of improved metacognitive activity is the actionable knowledge that results in the conscious ability to make a different decision, to 'understand, appreciate and act' as Mezirow (1990) described inside of the various phases of self-regulated learning. The *personal* aspect of improving metacognitive activity is that individual gains in terms of metacognitive self-knowledge will be dependent on the individual, but also can be supported by other individuals including peers and instructors (taking a Vygotskian approach to reflection in learning). As a description of metacognitive activity, Molenaar et al. (2010, 2014) propose that learning should be measured not only in terms of general metacognitive activity but differentiated between the various phases of a learning process, from orientation and planning, to monitoring, evaluation and reflection. As can be seen in the following sections describing the study in more detail, we connect this idea with the concept of self-regulation to help us identify moments of metacognitive activity related to specific phases and areas of self-regulation.

2.4 Scaffolding reflexive practice in non-formal learning environments

What Hadwin and Oshige (2011) and Hadwin, Järvelä and Miller (2011) define as 'socially shared regulated learning' is essentially deliberate learning that is supported through exchange of ideas, strategies and evaluations within a group of learners engaged in the same learning activity. Returning to Dewey's description of the conditions under which reflexive thought takes place, collaborative reflection can serve the purpose of testing and validating ideas as well as expanding an individual's explorations of their own constructs to include those of others. However, Dewey also qualified this, stating that the collaborators should be those who *value the process and what it can serve*. This condition is not always met in collaborative, non-formal learning environments, in which participants enter the learning environment with different motivations. It is not surprising, therefore, that research indicates that collaborative work can be the most effective when supported through facilitated means or learner scaffolding (Järvelä and Hadwin, 2013). Identifying exactly what kind of support and how to deliver it is a key research interest in studying socially constructed metacognitive activity and reflection in collaborative learning environments (Azevedo et al., 2005).

The use of technology for supporting reflexive practice involves examining user perspectives and performance, but also the appropriateness for the learning domain and task. Most technology for learning is developed to support formal learning (Ley et al., 2014), which may not translate in non-formal learning environments. Ley et al. (2014) recommend integrated approaches, in which technology scaffold learning at the individual, social and semantic levels. This includes the provision of prompts to elicit certain metacognitive or reflexive processes. The efficacy of such prompts depends on the learning goal and which types of learner activities will best serve this goal. Bannert and Mengelkamp (2013) confirmed this in their exploration of reflection prompts, metacognitive prompts and training and metacognitive prompts with university students. They discovered that, whilst each type of prompt had a positive effect on learning, the types of effects these prompts had differed significantly. For self-regulated learning, certain types of prompts may encourage more or less metacognitive activity around only

certain aspects of self-regulation, such as task orientation, monitoring or reflection (Ley et al., 2010).

For the study presented in this paper, we chose to examine the potential of non-adaptive prompts (in the form of a reflection guide) as a type of scaffolding intervention to improve metacognitive activity both during and after a collaborative task. A non-adaptive prompt is one that is provided to participants without real-time knowledge of their current location inside of a mental process (Azevedo and Hadwin, 2005). Examples of non-adaptive prompts may include study or reflection guides to which learners can refer at any point in their learning process. In contrast, an adaptive prompt (such as a question asked by a teacher during a classroom discussion or by an intelligent tutoring system during a certain activity) responds to learners' behaviour within a learning activity. Adaptive prompts have been shown to be more effective than non-adaptive prompts in improving metacognitive activity in some domains (Azevedo et al., 2005). Azevedo et al. found that students more readily perceived the utility of adaptive prompts and could apply them more effectively in their study of the human circulatory system. However, adaptive prompts are costly and complex to develop (Azevedo et al., 2005) in terms of the technology implied or human resources required. Additionally, the efficacy of adaptive *versus* non-adaptive prompts for ill-structured learning scenarios is not as well established as it might be for the sciences (Chen and Bradshaw, 2007). We felt further investigation was warranted to explore if non-adaptive prompts could be modified in such a way as to be more helpful to the learner in certain phases of self-regulated learning in non-formal settings. We also wanted to qualitatively observe how participants utilised prompts, so that this could inform the development of adaptive prompts in the future.

When investigating which types of prompts to utilise in preparing the present study, we built upon the research of Molenaar, Sleegers and Van Boxtel (2014), Molenaar, Van Boxtel and Sleegers (2010), who have experimented with various types of metacognitive prompts and their impact on metacognitive activity in collaborative learning. In their research, Molenaar et al. found that problematising prompts, which ask learners to consider the importance of conducting certain activities during the learning process, were more effective in producing intense interaction and social, constructive metacognitive activity than *structuring prompts*, which direct learners explicitly to conduct those certain activities. For example, where a structuring prompt would tell a group of students to agree on a shared goal for an assignment, a problematising prompt would ask students to consider the *importance* of having a shared goal. Molenaar et al. (2010) found a positive correlation between the problematising prompts and a higher level of domain knowledge. The authors posit that the reason for this is that co-constructive activity has been shown to improve domain knowledge (Chi, 2009). Essentially, these findings indicate that engaging groups in a discussion on the learning process itself (as is the case with problematising prompts) triggers intense, constructive metacognitive activity, which is more effective in knowledge acquisition. For our study, we wished to test whether a further level of abstraction away from performing specific activities during a learning process and towards knowledge construction itself would be helpful in further increasing the intensity and quality of our participants' collaboration, in particular with regard to evaluation and reflection. Thus, we expanded their study with an additional study condition of 'epistemological scaffolding'.

In the 'goal setting' example afforded above, a structuring prompt should elicit the activity of setting a goal. The problematising prompt should also result in goal setting,

but the prompt is not activity-specific, which may be helpful for learning transfer. The problematising prompt asks participants to consider the *importance* of goal setting and allows the learner to consider *why* she should perform this activity, instead of simply prompting her to do it. This may be one reason for the connection between improved knowledge acquisition and problematising prompts. The structuring prompt may be perceived as relating only to the activity at hand, whereas the problematising prompt may be viewed as a more general item for consideration (Ge and Land, 2003). We felt that epistemological scaffolding could further abstract this thought process by asking: ‘how will you know when you have resolved this task?’ For ill-structured problems, this abstraction can be useful for future application. Inside of this type of prompt, there is room for examining what *kind* of task one is resolving, what *possible goals* could exist in resolving it, the need for *decision-making* and agreement on goal formation and finally, setting a goal. Whilst the end result of ‘goal setting’ should be unified across the different scaffolding procedures, the process of arriving at that goal is expected to be different for participants who are more explicitly guided, in comparison to those who arrive there through epistemological reflection.

Epistemic beliefs have been shown to influence learners’ cognition; from the way they formulate, plan and monitor strategies, to how they reflect on their performance (Greene, Muis and Pietschl, 2010). In a general sense, research indicates that a ‘sophisticated’ epistemic belief structure, which is constructivist in nature, may be more beneficial in a variety of settings than a ‘naïve’ or simplified conception of the nature of knowledge (Muis, 2007; Greene, Muis and Pietschl, 2010). In particular, as regards ill-defined problems, sophisticated epistemic beliefs can allow for the flexibility required in considering the subjectivity of proposals in solution finding and include the commitment to logic necessary in imposing structure on an ill-structured problem as necessary. As such, one would expect groups receiving sophisticated, constructivist epistemological prompts to exhibit more awareness of the subjectivity and complexity of the problem and to offer more logic-based approaches to bringing order to the problem.

3 This study

The study presented below aimed to examine techniques and strategies that could potentially affect an individual’s ability to self-regulate in online learning environments, including improving metacognitive skills through scaffolding as well as meaningful peer interaction. In particular, the study focused on phases of self-regulation associated with evaluation and reflection. Additionally, the study was positioned inside of the domain of non-formal learning and the types of problems typically facing non-formal learners.

The key questions with which this study is concerned are:

- 1 Which type of metacognitive scaffolding encourages the most social, constructed metacognitive activity during a collaborative assignment that is ill-structured in nature?
- 2 Which types of metacognitive scaffolding produce the most meaningful social, constructive metacognitive interactions amongst group members during the reflection phase of a collaborative assignment that is ill-structured in nature?
- 3 What are the effects of social, constructive metacognitive activity on individual metacognitive gain?

3.1 Approach and methodology

To investigate the key questions associated with this study, we developed a mixed-methods research design that required detailed observation of participant behaviour. The decision to collect observational data prompted us to conduct the study in a face-to-face learning environment, which we adjusted to simulate self-directed learning online. First, participants received a one-directional input session on self-regulated learning (described below), before commencement of the activity, to ensure that they understood the purpose of the learning activity from the perspective of the ‘instructor’ (researcher). Second, participants were provided randomly with one of three different types of metacognitive scaffolding, non-adaptive prompts in the form of a question guide, that participants were encouraged but not required to utilise. Third, the participants worked independently of the researchers, who were not present for the activity or did they interfere in any of the participants’ group work. The groups’ work was video recorded for observational and conversational analysis. Finally, we chose to conduct a quasi-facilitated reflection session at the end of the activity, in which all groups were present and the researchers asked only predetermined questions about the participants’ experiences with using the prompts for the assigned task. This session was also recorded. The researchers provided no follow-up questions or commentary to the participants’ responses. We felt that these conditions most effectively replicated the experience of a learner in an online or blended learning environment, in which the presence of an instructor may be limited, asynchronous or unavailable. The decision to conduct the study in this way will surely have impacted the participants’ social interactions, which is discussed later in the following sections.

Two types of metacognitive scaffolding were adapted from previous studies with an additional third type of scaffolding for comparison. The three types of metacognitive scaffolding are defined as ‘Structuring’, ‘Problematising’ and ‘Epistemological’. The ‘structuring’ condition (Molenaar, Van Boxtel and Sleegers, 2010; Molenaar, Sleegers and van Boxtel, 2014) provides learners with specific prompts to perform certain metacognitive activities at certain times. For example, a structuring prompt might direct the learner to set a goal, to evaluate progress or to reflect on potential challenges associated with the task. The ‘problematising’ condition (Molenaar, Van Boxtel and Sleegers, 2010; Molenaar, Sleegers and van Boxtel, 2014) encourages learners to think about the function of performing these activities and how they should be performed. Using the same examples as above, a problematising prompt would ask learners to consider why setting a goal is important, how progress can best be evaluated and the potential causes that might lie behind challenges in resolving the task. The ‘epistemological’ condition, as described previously, prompts learners to think more generally about the nature of knowledge, how it is constructed and its justifications. For this reason, the prompts have less to do with performing specific activities, such as goal setting, and more to do with assessing the general belief structures around resolving the task (Table 1). As mentioned previously, research literature supports the claim that learners with a more ‘sophisticated’ epistemological belief structure tend to outperform learners who do not, at least in formal learning environments (Schommer, Crouse and Rhodes, 1992; Muis, 2007). The epistemological scaffolding condition, therefore, attempted to encourage the participants to view knowledge as dynamic, developing and justified through logic and reason.

Table 1 Scaffolding conditions and examples

<i>Scaffolding condition</i>	<i>Example</i>
Structuring prompts	Discuss what you think this task is about within your group Choose a strategy for arriving at a joint decision Consider which aspects of your group collaboration were helpful in resolving the task
Problematising prompts	Why is it important to understand the task? How can you keep your group on track? Why did your strategy work or not work?
Epistemological prompts	How will you know when you have completed this task? What evidence will you consider to help you make a decision? How will you recognise when your group is having difficulty?

Table 1 lists the three types of scaffolding conditions, along with several examples of the type of prompt provided in the given condition. It should be noted that this study did not include a control group, as it has already been demonstrated in the research literature that provision of metacognitive prompts has a positive effect on improving metacognition (Ge and Land, 2003; Azevedo and Hadwin, 2005; Azevedo et al., 2005; Molenaar, Van Boxtel and Slegers, 2010; Molenaar, Slegers and van Boxtel, 2014).

The associated assumptions or hypotheses associated with this study were:

- *Groups with epistemological prompts will display more incidents of co-constructed metacognitive activity than other groups.*
- *Groups with epistemological prompts will conduct more in-depth, interactive reflection rounds at the conclusion of the learning activity than the other groups.*
- *Individual members of groups in the epistemological scaffolding condition will report more metacognitive gains after the task has ended.*

4.2 Description of the study

4.2.1 Participants

The participants in this study ($n = 18$) were chosen randomly from a group of young adults (aged 18–27), who were required as part of a government sponsored development and mobility program to take part in a preparatory seminar for performing voluntary work abroad. The study was conducted outside of the normal seminar working times with participants' consent.

Participants provided their demographic information (concerning identifications of race, class, ability and any other self-identification they felt was relevant to disclose). Participants were all residents of Germany and German speaking, all white (with the exception of one participant who was identified as Asian) and all from the same socio-economic class (with the exception of one participant who described her economic background as 'below the poverty line'). In addition, all participants have received the same level of education, 18–19 years of formal education (with the exception of one participant who left school at 16 to learn a trade and two participants who had some

college or University-level classes). Of the 18 participants, five were identified as male and 13 as female.

The class was divided into six triads, so that two triads would receive each type of metacognitive scaffolding: structuring, problematising and epistemological. The triads were assigned to their scaffolding conditions randomly.

4.2.2 *The procedure*

Before dividing the group into their triads, all participants received training on the concept of self-regulated learning. None of the participants reported prior knowledge about the concept. During a 30-min session with the researcher, participants reviewed the basic components of self-regulated learning (cognition, affect, behaviour and context) as well as the sequence of activities in which self-regulated learners typically engage (orientation, planning, monitoring, evaluation and reflection). In addition to this brief workshop, participants were also given detailed written information on the process of self-regulated learning, along with a simplified reference sheet (adapted from Pintrich, 2004).

After this session, participants completed a short, written pretest for which the participant was asked to describe, in as much detail as possible, how they would resolve the task that they were about to complete as part of a small group.

Following the pretests, participants were grouped into triads and sent to their individual working spaces to await further instructions. Each scaffolding condition had an accompanying guide that provided the directions for resolving the task, a description of the task and a list of questions (prompts) to support the participants' orientation, planning, monitoring and reflection relative to the given task. Each triad received an additional training in the use of the guide from the researcher before the task began.

The participants were left alone to complete the task in their groups. Each triad received 20 min to complete the task and was asked to record the session using the audiovisual equipment provided.

Upon returning from their collaborative work, each participant completed a post-test, in which they were asked to reflect on their learning gain from the task and what they would do differently, if presented with the same or a similar task in the future.

At the end of the post-test, participants then gathered as a larger group and discussed their experiences with applying the scaffolding to the task they were asked to resolve. Participants were welcome to offer more information or discuss with one another various aspects of the activity. However, the researchers only asked the participants three direct questions. First, all participants were asked to respond to how they felt the prompts influenced their work (if at all). Second, all participants were asked to compare what they had written in the pretest to how the group had actually resolved the task. Last, participants were asked if there was anything else they would like to share about their participation in the activity. These sessions were recorded, with the researchers present.

4.2.3 *The task*

As mentioned previously, the participants were asked to collaborate in completing an assignment that was ill-structured in nature. The task presented to participants was to agree upon a ranking of 5 characters in a short story, from the best to the least well-behaved, using the numbers 1–5 (where 1 was the worst-behaved character and 5 was the

best-behaved character). The short story involved the highly subjective nature of morality and choice, making a definitive, objective solution to the problem impossible. The nature of the task also made it possible to partially control for prior knowledge. Whilst participants brought their skills in learning, collaboration and argumentation to the task, no one participant had additional information relevant to the task than what was provided to them in the written scenario.

4.2.4 Measures

As learning outcomes in non-formal education do not necessarily include formal assessments (with the exception of some vocational training), research in this domain requires additional methods for measuring learning gain from a given educational activity. This may be especially true for ill-defined problems that do not have a particular solution with which other potential solutions can be easily compared. As mentioned previously, metacognition is a significant predictive factor in learning (McCormick, 2003). Therefore, for this study, we utilised a combination of self-report measures (pre and post-tests) and think-aloud protocols, which were analysed using conversational and discourse analysis for identifying metacognitive activity and metacognitive gains. We also conducted a qualitative analysis of observational data to supplement and validate our findings. This included detecting interest/disinterest, group dynamics and individual characteristics that may influence results.

Social metacognition was measured through conversational analysis of the think-aloud protocols generated from the recorded sessions of each triad, with the unit of analysis being the turn of each speaker ($n = 2021$ for the group work and $n = 182$ for the final reflection round). Each turn of the group work was coded using the main and subcategories in the coding scheme employed by Molenaar, Slegers and van Boxtel in their study on the “effects of scaffolding on intra-group social metacognitive interaction” (2014) (Tables 2 and 3). All codes were exhaustive and exclusive. In the case in which a conversational turn contained different types of activity, in the form of distinct and separate statements by the same speaker, they were coded as individual turns.

Table 2 Main categories of conversational turns

<i>Main category</i>	<i>Description</i>
Metacognitive activity	Turns about monitoring and controlling the cognitive activities during learning
Cognitive activity	Turns about the content of the task and the elaboration of this content
Relational activity	Turns about the social interaction between the students in the triad
Procedural activity	Turns regarding the procedures to use the equipment or materials provided
Teacher researcher	Turns made by the researcher
Off task	Turns not relevant to the task
Non-codable	Turns too short or unclear to interpret

Source: adapted from Molenaar, Slegers and van Boxtel (2014)

Table 3 Subcategories of conversational turns

<i>Subcategory</i>	<i>Description</i>
Orientation	Orientation on prior knowledge, task demands and feelings about the task
Planning	Planning on the learning process, for instance, sequencing of activities or choice of strategies
Monitoring	Monitoring of the learning process: checking progress and comprehension of the task
Evaluation	Evaluation of the learning process; checking of the content of learning activities
Reflection	Reflection on the learning process and strategies through elaboration on the learning process

Source: adapted from Molenaar, Slegers and van Boxtel (2014)

For this study, the researchers focused primarily on identifying metacognitive activities, which were represented by turns in which the participants considered, negotiated and controlled the strategies they were employing to resolve the task. In contrast, cognitive activities were distinguished from metacognitive activities in the extent to which they related to the critical thinking and cognitive processing of the task without referring to specific strategies of the group to resolve the task (Kitchner, 1983). For example, a cognitive statement might refer to the moral deliberations a participant was making about the short story that was provided to them as part of the task. A metacognitive statement would refer to how the group decided to deal with different value systems that might make the discussion of morality difficult. Relational activities included turns that involved task-related interactions such as task division. Unlike Molenaar et al. this study did not include a virtual learning environment with which participants were engaging. Thus, procedural activities in the coding scheme referred to turns about using the audiovisual equipment or other materials provided. Any turns by the researcher were coded as Teacher Researcher and any turns that were not related to the actual task were coded as Off Task. Finally, any turns that could not be clearly assigned to one of the other categories, due to their brevity or incompleteness, were assigned as non-codable.

The subcategories assigned to all activities coded as 'metacognitive' included turns about orientation, planning, monitoring, evaluation and reflection. These codes correspond with the phases of self-regulation as described by Pintrich (2004), which were presented to the participants both in the initial input session and in written form. These codes were also exhaustive and exclusive. Orientation activities were those in which participants considered the meaning and purpose of the task, their feelings about the task and activation of prior knowledge. Planning activities were those in which the participants planned how and when to engage in certain activities or strategies whilst resolving the task. Monitoring activities were those in which participants were checking their progress or negotiating changes to activities and strategies. Evaluation and reflection activities, which can be difficult to discern were coded on the basis of how closely they related to specific activities of the group (as is the case with evaluation) or the extent to which they more generally described the learning process (reflection). In the analysis, we utilised these codes to determine the extent to which certain types of prompts elicited certain types of regulatory behaviour, as determined by the metacognitive statements of the participants.

The coding scheme was validated through inter-rater agreement calculated using Cohen's kappa on two transcripts chosen at random from the 6 triads and independently coded by a second rater. Agreement for the main category was high (Fleiss, 1981), with $K = 0.82$. Agreement was the highest for the category of metacognitive activities and lowest for relational activities. Agreement for the subcategories was good (Fleiss, 1981), $K = 0.746$, with the highest level agreement for planning and the lowest level of agreement for evaluation.

The response of the group members to the metacognitive activities of other members was analysed using four codes for intragroup metacognitive interaction adapted from Molenaar, Sleegers and van Boxtel (2014): ignored, accepted, shared and co-constructed. Ignored metacognitive activities were those activities with which the other members of the triad did not engage. An example of an 'ignored' metacognitive activity might be the statement 'This is getting complicated', to which no other group member responds. Metacognitive activities were coded as 'accepted' in the cases where it was clear that the group had incorporated the comment into their group work. An example of this might be when a group member suggests a certain strategy and the group implements that strategy without discussion. 'Shared' metacognitive activities, on the other hand, are those that are explicitly supported by another member of the triad. For example, a group member suggests that a certain strategy should be renegotiated and another group member responds that he or she agrees. Finally, turns that were coded as 'co-constructed' were turns in which the other members of the group continued to engage with the subject in a kind of 'metacognitive episode' (Molenaar, Sleegers and van Boxtel, 2014), or a series of turns relating to one metacognitive activity. Cohen's kappa for these codes was $K = 0.87$, indicating a high level of agreement between the two raters (Fleiss, 1981).

The quality of metacognitive activity was measured in three ways. First, a 'co-constructed' metacognitive activity was judged to be of potentially higher quality than one that is 'ignored', 'accepted' or 'shared', because it indicates new knowledge being formed amongst the members of the triad (Molenaar, Sleegers and van Boxtel, 2014). However, the instance of new knowledge being formed does not necessarily mean that it is quality knowledge. The second measure of quality was obtained through analysis and coding of the resulting rhetorical relations (Jasinskaja and Karagjosova, 2015) that occurred in the dialogue following (Table 4). When a metacognitive turn was followed by additional turns in which the original statement was reiterated, summarised, specified or more generalised, those turns were coded as 'elaboration'. When the following turn proposed an explanation for a phenomenon observed in a previous statement, it was coded as an 'explanation'. A turn was coded as a 'parallel' rhetorical relation when a speaker drew a comparison between the triggering unit of discourse (the original metacognitive statement) and another situation/unit of discourse. 'Contrasting' rhetorical relations were those in which the turn demonstrates the comparison of contradiction between two units of discourse. Rhetorical relations coded as 'result' connected an effect to a previously given cause. When the turn simply offered a continuation on a theme in a sequenced fashion, it was coded as a 'narration'. When the participants were engaged in questioning and answering or in acknowledgement of each other's statement, these turns were coded as 'dialogue RR'. These codes were not exhaustive, as some turns within a metacognitive episode may not qualify as a rhetorical relation, such as arbitrary utterances of disparate information (Jasinskaja and Karagjosova, 2015).

Table 4 Rhetorical relations of conversational turns

<i>Rhetorical relation</i>	<i>Description</i>
Elaboration	Turns in which the speaker reframes or adds to the previous unit of discourse
Explanation	Turns in which the speaker offers a cause for a specific effect given in a previous unit of discourse
Parallel	Turns in which the speaker draws comparisons of similarity between two units of discourse
Contrast	Turns in which the speaker exposes contradictory relationships between two units of discourse
Result	Turns in which the speaker offers an effect for a specific cause given in a previous unit of discourse
Narration	Turns in which the speaker connects two other units of discourse in sequence
Dialogue RR	Turns in which the speaker either acknowledges the statement of another speaker or engages in question and answering

Source: adapted from Jasinskaja and Karagjosova (2015)

For this study, we only conducted an analysis of rhetorical relations on episodes of co-constructed metacognitive activity related to evaluation and reflection activities inside of the task and on all statements delivered as part of the final reflection round. The reason for limiting the analysis of the reflection round to rhetorical relations (and observational analysis) was that the participants were already engaged in metacognitive activity as guided by the three questions that were provided by the researcher. Co-constructed metacognitive episodes were considered of higher quality when they resulted in a greater variance and number of interactive rhetorical relations following a metacognitive activity. In the analysis of the final reflection round, reflections that were not simple narration or elaboration on what the group had done to resolve the task, were considered of higher quality. For example, statements consisting mostly of reporting on the group's activities were analysed as having less value than statements that drew parallels or contrasts between different group's activities, or those that provided detailed explanations of the group's choices and the impacts those choices had. Cohen's Kappa for these codes was $K = 0.782$.

Finally, *individual metacognitive gain* was measured through analysis of the participants' self-reporting in the post-test, as compared to the statements given in their pretest, relative to how they would go about resolving the same or a similar task in the future. This measurement was taken to ascertain how participation in the group work altered the participant's perspective on resolving such a task. Metacognitive gains were coded as relating to cognitive, motivational, behavioural or context-related features.

4.3 Analysis

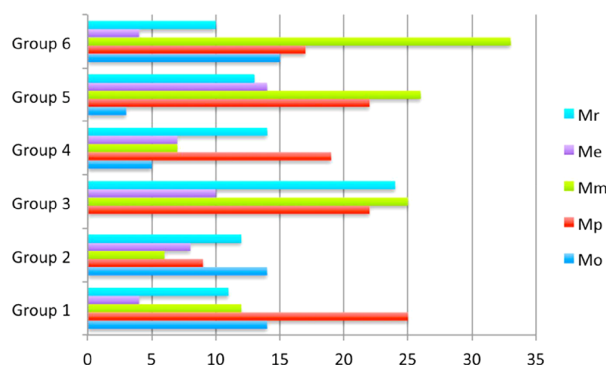
In the analysis of this data, we were looking for indicators of self-regulated learning, in particular during reflection phases of the activity. Using the coding scheme provided by Molenaar, Slegers and van Bortel (2010; Molenaar, Slegers and van Bortel, 2014), we identified patterns of self-regulation in their learning processes by following the metacognitive statements made within the group work and in the final plenary session,

which illustrate their movement through the various phases of self-regulation described by Pintrich (2004). It is important to note that, for the analysis, we were less concerned with the cognitive processes the group used to resolve the actual task. The aim of this study was not to assess the participants' general critical thinking skills. Rather, our interest was in identifying the conversational turns that had to do with the metacognitive processes of the group, in which they describe, evaluate and modify the overarching strategies undertaken by the group to resolve the task.

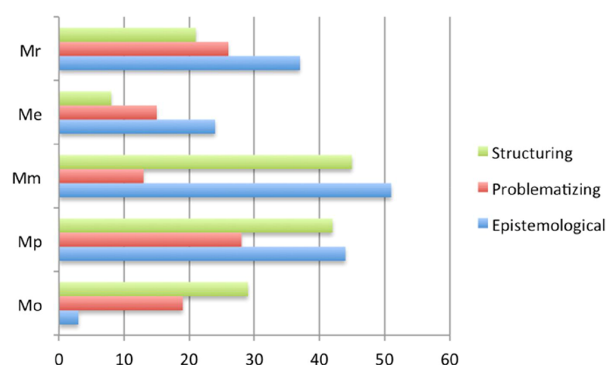
Moreover, in this study, we were examining reflection using two different models. In one model, based on Schon (1983), participants should be reflecting iteratively throughout the process of resolving the task. Thus, we were looking for indicators that reflexive activity was taking place during the triads' collaboration on the task. Any statement, therefore, in which the participant was aware of the group's strategy and able to demonstrate critical thinking related to that strategy, across any phase or area of self-regulation, was coded as a reflection activity. For example, one group experienced a phase of demotivation brought on by a lack of sleep, which they all agreed was affecting the quality of their work. They decided to take a few minutes to sing, after which they all agreed that this helped them to raise the group's motivation. Though this process is related to the group's motivation and took place during a monitoring phase of the group's work, it is still a reflection. At the bookends of the group task (the pretest, post-test and final reflection round), we were looking for indicators of a different model of reflection based on Kolb's (1984) Learning Cycle. One of the most common reflection models, Kolb's 'do', 'reflect', 'decide' cycle illustrates how learners transform an experience into a learning opportunity through considering the event from multiple perspectives and understanding how to abstract what they have learned for future application. On the basis of this model, we evaluated the quality of participants' statements, using rhetorical relations as our measure.

4.3.1 Metacognitive activity by scaffolding group

To assess the more general effects of the different metacognitive scaffolds, we analysed between 25 and 35 min of recorded conversation for each of the six triads and transcribed these conversations for conversational analysis. Our unit of measurement was the conversational turn of individual speakers ($n = 2021$). Of those turns, 482 were identified as 'metacognitive', 55 were categorised as relating to 'orientation', 136 were coded as 'planning', 129 were coded as 'monitoring', 60 were recorded as 'evaluation' and 102 were coded as 'reflection' activities. Figure 1 shows the frequency of the different subcategories of metacognitive activity by group. The metacognitive activity most often identified within the groups was 'planning'. The activity least often identified was 'orientation'.

Figure 1 Metacognitive subcategories by individual group (see online version for colours)

In Figure 2, the frequencies of the different types of metacognitive activity are distributed according to the scaffolding group. Participants in the epistemological scaffolding condition exhibited more metacognitive activity than either of the other two scaffolding groups in all subcategories except for orientation. In orientation, the structuring scaffolding condition appears to produce more metacognitive activity amongst group members than all other groups, in particular the epistemological group. However, overall, the epistemological group produced the greatest number of metacognitive activities ($n = 156$). This condition only slightly outperformed the structuring condition ($n = 145$). The problematising condition produced the lowest number of metacognitive activities ($n = 101$).

Figure 2 Metacognitive subcategories by scaffolding group (see online version for colours)

4.3.2 Co-constructed metacognitive activity by scaffolding group

In order to more fully understand the quality of social interactions triggered by certain metacognitive activities, we assessed the number of co-constructed metacognitive episodes that occurred in each group (Figure 3) and the frequency and type of rhetorical relations that were involved in each co-constructed metacognitive episode (Figure 4). As we were most interested in the effects of the scaffolding procedure on the reflection phase of the group's collaboration, we limited our analysis to the metacognitive episodes related to evaluation and reflection.

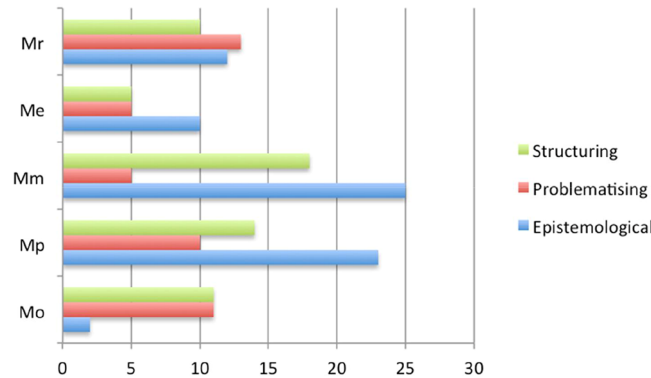
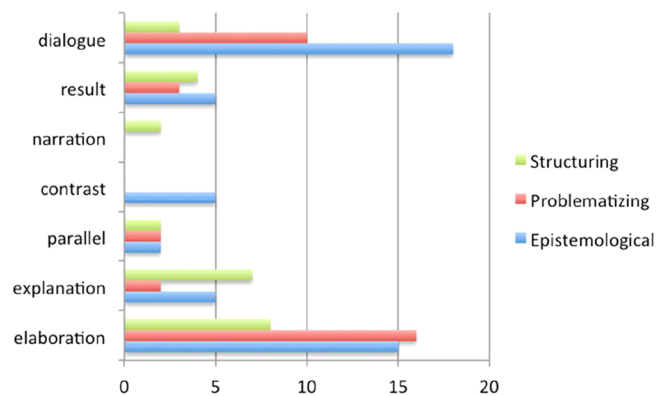
Figure 3 Co-constructed metacognitive activity by scaffolding group (see online version for colours)**Figure 4** Rhetorical relations in co-constructed metacognitive evaluation and reflection by scaffolding group (see online version for colours)

Figure 2 illustrates that participants in the epistemological scaffolding group had more instances of co-constructed metacognitive activity related to planning, monitoring and evaluation than either of the other two scaffolding groups. Both the problematising and structuring scaffolding groups exhibited more co-constructed metacognitive activity in orientation, whilst the problematising scaffolding group had slightly more co-constructed metacognitive activity with regard to reflection. However, when not divided into subcategory, the epistemological scaffolding condition produced more co-constructed metacognitive activity ($n = 74$) than either the problematising condition ($n = 44$) or the structuring condition ($n = 58$).

Whilst Figure 3 only relates to instances of co-constructed metacognitive activity, we did collect frequencies of ignored, accepted and shared metacognitive activity as well. The epistemological scaffolding condition produced slightly more ignored metacognitive activity than either of the two groups ($n = 4$), whereas instances of accepted metacognitive activity were more than double that of the other two groups ($n = 13$). Instances of shared metacognitive activities were similar for both the epistemological and

problematising scaffolding groups ($n = 6$ and $n = 5$ respectively), but were significantly higher than that of the structuring group ($n = 1$).

With regard to the social interactions inside of a co-constructed metacognitive episode, Figure 4 illustrates that the epistemological scaffolding condition resulted in more rhetorical relations than other of the two groups ($n = 50$ for the epistemological group, $n = 33$ for the problematising group and $n = 26$ for the structuring group). In particular, there was significantly more dialogue than in either of the two other scaffolding groups. Problematising scaffolding tended to produce more instances of elaboration than any other type of rhetorical relation, whilst structuring scaffolding produced more even numbers of each of the different types of rhetorical relations with a slight tendency towards elaboration and explanation.

4.3.3 *Observational data from the triads*

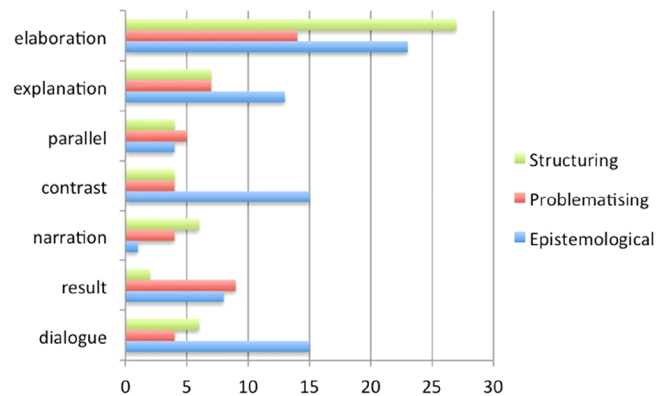
Observational data from the individual groups support the analysis described above. Groups in the epistemological scaffolding condition appeared to have more evenly distributed contribution from all of the group's members and members tended to ask other group members explicitly for their opinions and ideas about how to resolve the task. This may be partly due to how each of these groups chose to resolve the task. In both cases, the group with epistemological scaffolding developed a complex point system to establish the relative morality of each character's behaviour. For example, one group assigned positive or negative points to each character based on whether their action helped or hurt another person. Whilst this system is still value laden, it was considerably less reliant on value judgements than solutions generated by the other four groups. In terms of bringing structure to an ill-structured problem, members of the epistemological scaffolding groups demonstrated stronger ability to bring order to a highly subjective task in a way that was effective in producing a collaborative and justifiable result. In contrast, all other groups approached the task as a debate, in which each member offered their opinion and argued its merits based on their own individual value systems, which were often emotional in nature. Whilst these deliberations were generally faster (on average the groups that received epistemological scaffolding required 6–10 additional minutes to complete the task), the groups in epistemological scaffolding condition produced approaches that were more equitable and did not require that the participants argue their cases emotionally.

4.3.4 *Analysis of the final reflection round*

For the final reflection round, we analysed approximately 25 min of recorded conversation amongst the six triads. Our unit of measurement was the conversational turn of individual speakers, divided into discrete statements ($n = 182$). To assess the quality of these exchanges, we analysed the rhetorical relations between the participants' statements (Jasinskaja and Karagjosova, 2015) (Table 4). Of the 182 turns, 11 involved narration, 64 were elaborations, 27 were explanations, 13 were parallels, 23 were contrasts, 19 were results and 25 were dialogue rhetorical relations. Figure 5 illustrates that the groups receiving epistemological scaffolding contributed approximately twice the number of explanations than any of the other four groups. In addition, they generated nearly triple the number of contrasting statements (possibly related to how differently these groups resolved the task, which is discussed below). Finally, the groups receiving

epistemological prompts contributed to more than half of all dialogue that occurred in the reflection round. These tendencies are also visible when the two epistemological triads are divided and compared with the other scaffolding conditions.

Figure 5 Rhetorical relations in the final reflection round (see online version for colours)



4.3.5 Observational data from the reflection round

In the observational analysis of the reflection round, it is clear that the approach taken by groups that had epistemological scaffolding generated the most interest from other participants. Nearly all of the dialogue that is attributed to other groups represents questions posed to members of the epistemological scaffolding groups about their deliberations or mechanisms for resolving the task. The non-verbal language of the participants supports this and is indicative of interest (leaning in, holding eye contact with the speaker). Additionally, the high number of contrasting statements by members of the group receiving epistemological prompts can be attributed to those groups' different approach to resolving the task. As each participant was required to provide some statement, most participants chose to narrate and elaborate on the choices their group made during the activity, without commenting significantly on the impact of those choices or their reasoning behind them. As a result, many participants made statements about the similarity of their approach to that of the others. However, as members of the groups with epistemological scaffolding resolved the task without deliberation in the same way as other groups, they were often charged to explain their approach and their reasons for applying what were perceived as complicated strategies for a simple task.

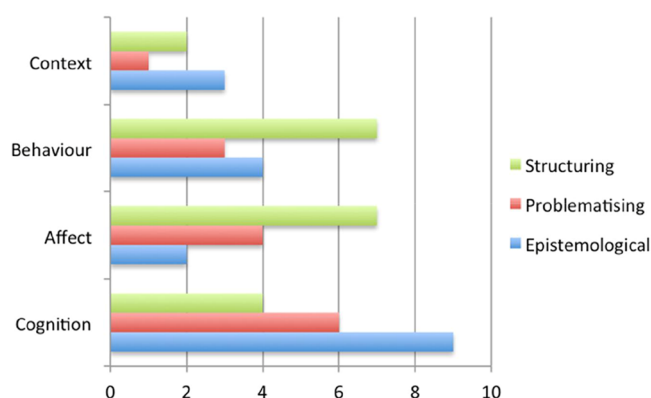
Surprisingly, when asked in the final reflection round if the participants perceived differences between what they had written down in the pretest and what the group had actually done to resolve the task, most participants felt that what they had written down was similar to what the group had actually done. From the recordings and the post-tests, it is possible to determine that this is not the case. This may be an indicative of harmonisation processes that take place after an activity is in the past. However, it is concerning in that participants were unable to vocalise those differences. It makes it difficult for an instructor to understand the level of awareness an individual has about her learning, if the individual cannot communicate it. In addition, most participants did not attribute their strategies for resolving the task to any of the prompts, despite the differences that were clearly visible between the different scaffolding groups' approaches

to the task. This generates questions about how interventions such as these are perceived by the learner. If learners do not connect scaffolds with learning processes and outcomes, how are they to understand how and when to apply this information in a future learning scenario?

4.3.6 Individual metacognitive gains

As mentioned previously, individual metacognitive gain was measured from the participants' self-reported learning outcomes given in the post-test. An analysis of the number of metacognitive gains did not yield significant differences between the three scaffolding conditions. However, there were some qualitative differences amongst the three groups. In Figure 6, the metacognitive gains of the participants (according to their scaffolding group) have been coded to one of the four major areas of self-regulation: cognition, affect, behaviour and context. One can see that groups in the epistemological condition produced more metacognitive gains related to thinking (cognition). The groups in the structuring condition produced the majority of affect and behaviour-related gains.

Figure 6 Individual metacognitive gains according to scaffolding condition (see online version for colours)



Looking more deeply at the post-tests, the epistemological scaffolding groups had metacognitive gains that were either epistemic in nature, or related to orientation. For example, 'Andy' described in his pretest a very formulaic set of instructions of how he would go about resolving the given task:

"Everyone writes the story and makes a ranking on their own. After 5-10 minutes we compare the rankings of each person. Using the principle of majority rules, we vote on one ranking. The list can always be changed if there is a problem, but in the end, the majority of people should be satisfied with the solution."

In his post-test, Andy writes:

"We had a list with categories and created facts through this. I would do it the same next time as well, but maybe decide on the categories before starting so that the list is less complicated. However, I think that it was good that self-generated facts influenced our decision and not just emotions."

Andy's knowledge that the group's 'facts' were self-generated is indicative of his epistemic metacognition in that he describes the mechanism by which the group attempted to bring structure to the problem of morality. From the recordings, it is clear that the group negotiated the terms 'good' and 'bad' behaviour, and then applied that criteria to all characters equally. Moreover, Andy notices the lack of orientation on the task that is visible in the data in that he recognises the categories should have been established much earlier. Similarly, Jenny (who was in the same group as Andy) writes in her pretest:

"List all of the characters (1 min). Write next to their names the worst thing that they have done (2 min). Discuss what things are how bad (10 min). Write it down. (1 min)."

In her post-test, she writes:

"It is good to distinguish between facts and perceptions. One should always discuss everything, before you start working in a group, otherwise there are misunderstandings."

This statement is also indicative of an epistemic metacognitive gain, as it relates to the construction of knowledge and how their decisions on how to interpret the characters' behaviour impacted the outcome. Similarly to Andy, Jenny also notes the lack of orientation in the group as having contributed to their misunderstandings.

For the problematising condition, the most commonly identified metacognitive gain had to do with recognising the opinions of others and dealing with such differences in a strategic way, which may support the use of problematising prompts for investigating context in self-regulated learning:

Georgia: "First consider if the other person might be of a different opinion than you, before you get hardened to your own opinion."

Harry: "Before making a decision it is good to first discuss things in the group. If you also take into consideration the standpoint of others in your own consideration of the issue, you can come up with a more differentiated decision. The likelihood of everyone being satisfied with the group decision will be higher."

Justin: "Opinions quite often depart from one another, so it is important to be able to be responsive to the good arguments of others."

There were also two participants in the problematising scaffolding condition who reported that they did not feel they had learned anything and who completed the post-tests with the following statements: 'I wouldn't do anything differently' and 'I resolved this task like I always do.'

In the structuring condition, participants most commonly mention gains associated with motivation and task environment. For example, in one group, the entirety of their metacognitive gains had to do with the group's decision to sing when they felt demotivated or had arguments within the group.

Nancy: "Always have fun. Then you are open to the suggestions of others."

Ginger: "Take a break when the motivation gets low. Sing!"

Ingrid: "Sing when your motivation is low (or to stay motivated)"

For the other group in the structuring condition, the gains were primarily about keeping peace and order within a task.

Josh: "One should approach problems like this peacefully."

Sally: "Peace and constructive dialogue without getting loud helps to resolve the task fairly."

Esther: "One person should lead the discussion in order to bring in peace."

When looking at the transcripts, such gains are directly related to the ways in which the participants actually resolved the task. In no group did the group resolve the task in the exact way that any one member had proposed in the pretest. In addition, only five participants indicated in the pretest what they would do if there were disagreements in the group when attempting to resolve the task. This was surprising, considering the nature of the task, and it makes sense that many of the metacognitive gains assessed through the post-tests are related to collaborating on problem-solving.

5 Discussion

This study investigated social, co-constructed metacognition in non-formal education by examining group collaboration on an ill-defined task that more closely represents everyday personal and professional learning. The study explored the effects of three different types of metacognitive scaffolding on social, co-constructed metacognitive activity, in particular during the phases of self-regulated learning in which the group was concerned with evaluation or reflection on the learning process. We performed a conversational analysis on six triads of learners and found that different types of metacognitive scaffolding have varying effects on the social co-constructed metacognition of learners, depending on what type of metacognitive activity with which the group is engaged. This is in line with previous studies, for example, the above-mentioned study by Bannert and Mengelkamp (2013) on reflection, training and metacognitive prompts as well as Chen and Bradshaw (2007) on knowledge integration prompts. In both cases, the authors discovered that all prompts had a positive outcome for learners, albeit in different areas of their learning processes. For technology-enhanced learning, it will be necessary to determine when to offer which types of prompts to trigger the necessary activities required for a particular learning phase, goal and domain.

Returning to the hypotheses outlined previously in this document, we utilised both qualitative and quantitative analyses to test and confirm, reject or elaborate on our original hypotheses. Whilst the epistemological scaffolding condition did produce more social metacognitive activity than either of the other two groups, it did not display more incidents of co-constructed metacognitive activity across all phases of self-regulation. In particular, with regard to orientation activities, both the structuring and problematising scaffolding conditions outperformed the epistemological. This was not in line with expectations, considering that the epistemological scaffolding provided focused primarily on epistemological orientation and the necessity for negotiation around the definition of knowledge and its justifications. However, the number of planning and monitoring activities was quite high, perhaps indicating that orientation-related activities were replaced during these types of exchanges. Moreover, in the final reflection round, through comparison with other groups, participants in the epistemological scaffolding condition did appear to recognise the differences in their approach and the apparent way in which they oriented themselves towards the task.

Initially, we proposed one possible explanation for the lack of orientation activities that involved the extent to which the different groups (regardless of their scaffolding condition) followed the directions provided by their guidelines. Using the transcripts and recordings as evidence of the group following the full directions explicitly, we divided the groups into two categories, those groups that followed the entire set of directions on the guideline and those that did not. By chance, there were three triads in each group. We then analysed the difference in frequency of metacognitive activity between those two categories. What we found was that the only significant difference between the groups who explicitly followed all of the directions and those that did not was with regard to metacognitive orientation activity. Orientation activities are those in which learners activate prior knowledge, consider task value and meaning, and connect with their feelings and motivations relative to the task. Groups that followed directions had 43 metacognitive turns related to orientation in comparison with groups that did not, which produced 8. This indicates that metacognitive orientation may not be a 'natural' part of learners' approach to a new assignment or task in non-formal environments. Learners may need some additional support from instructors or from their learning environment to perform these types of activities. The success of structuring prompts in triggering orientation activities supports this. This result is in keeping with findings that learners tend to have difficulty transferring knowledge from one learning environment to another (Buckingham Shum and Deakin Crick, 2012; Ge and Land, 2003; Van den Boom et al., 2004).

An additional expectation that we had before conducting the study was that the problematising scaffolding condition would produce more social metacognitive activity than the structuring scaffolding condition. However, the structuring scaffolding condition performed quite well in this study in relation to the other two scaffolding conditions. This result is in contrast to that of Molenaar et al. (2014) study on scaffolding and intragroup social metacognitive interaction.

One possible explanation for this particular issue may have to do with the distribution of learners according to their ability. In this research environment, there was no possibility of assessing the participants' skills in self-regulated learning or critical thinking. Thus, it may have been that groups were unevenly distributed in terms of stronger and weaker learners. From looking at the transcripts and recordings in more detail, one can begin to see certain 'leaders' emerging amongst the participants, those who have the lion's share of the conversation and who often perform most of the metacognitive activity 'alone' (with the other participants either agreeing or sharing these thought processes in the majority of cases). In one of the groups receiving structuring prompts, one person contributed more than 75% of the conversation inside of her group and 85% of the conversation related to her group in the final reflection round. Whilst it was not within the scope of this investigation to go more deeply into this, one suggestion for future analysis would be to explore the individual group members and their particular contributions to the discourse and the specific rhetorical relations that occurred between themselves and the other members of their triad. However, it is telling that regardless of these features, the spread of rhetorical relations is similar between each pair group of scaffolding conditions, relative to the number of statements made.

Perhaps more importantly, from a qualitative perspective are the number and variety of rhetorical relations produced by the epistemological scaffolding condition. In particular, with regard to dialogue rhetorical relations, the epistemological scaffolding condition significantly outperformed the other two groups, which was indicative of a

more in-depth, interactive reflection round as presupposed in the introduction to this paper. Though the structuring scaffolding provided more variance in rhetorical relations, the epistemological group tended to ask more questions and provide more explanations for a given metacognitive statement than was elicited within the structuring scaffolding condition.

As mentioned previously, the extent to which learners perceive the utility of prompts is still an open question. Similar to the study of medical training simulations by Wesiak et al. (2014), we also found that participants did not always make use of prompts or recognise their value in the reflection phases of the activity. Wesiak et al. attributed this to workplace learning, in which learners are involved in the practice of their profession under the normal stresses of professional life and do not see themselves as immediate *learners*. Whilst our study conditions were less situated in a professional environment, the participants were engaged in parallel in a residential training course with other learning objectives than those described in this paper. It is possible that this influenced participants' perception of the task.

6 Conclusion

In consideration of the importance of social metacognitive interaction in supporting meaningful reflection, as was proposed by Dewey, this study contributes to researchers' and practitioners' understanding of how to trigger such interactions through use of scaffolding techniques, such as the non-adaptive prompts utilised in this study. The analyses and findings of this study indicate that providing epistemological scaffolding for ill-defined tasks can be effective in producing meaningful social metacognitive interactions amongst learners during the evaluation and reflection phases of their collaboration on a given task.

For scaffolding reflection in technology-enhanced learning, this is important for two reasons. First, this result indicates that scaffolds are best for reflection when they are social and trigger discussion. People have difficulty reflecting alone. They need comparison to learn. They need the social to share. Particularly in non-formal learning sessions, the only way to know what one is learning is to compare one's previous and present activity, or compare oneself with others. Many of the insights participants had about their strategies for resolving this task emerged in the final reflection round. Reflecting in groups necessitates that one vocalise one's actions and name them as well as providing other learners with new data for their own reflections. In our experience, epistemological prompts led to the most thoughtful and varied discussions during evaluation and reflection phases. Second, this provides insight into how instructors involved in online pedagogy can best support student collaborative work. As reflexive activities happen both within and after learning experiences, epistemological prompts allowed participants to assess more deeply the individual activities in which they were engaged during the activity. For socially shared regulated learning, this may give learners more access to specific and alternative strategies for moving through the phases of self-regulation. Instructors interested in supporting self-regulated learning online can consider well-placed epistemological prompts in learning forums as well as during synchronous classroom activities online. Likewise, structuring prompts may be more helpful for orientation activities in such contexts, providing learners with more detailed instructions that are relevant to this phase of self-regulation.

Three potential areas for future research, based on our findings, include epistemological scaffolding in instructional design of hypermedia learning environments, assessment of learning gain through reflection and further support of self-regulated learning in non-formal learning environments. With regard to the first area, it would be possible to continue building on the work of Molenaar, Sleegers and van Boxtel (2014) as well as Azevedo et al. (2005) on scaffolding techniques in hypermedia learning environments to support learners in their self-regulated learning. In particular, it could be useful to examine the effects of epistemological scaffolding on learners' self-regulated learning across all areas and phases. Whilst we did code orientation, planning and monitoring activities, it was not within the scope of this research to more fully unpack these phases in terms of a deeper qualitative analysis. Such research could aid in the investigation of how to support learners in developing a more sophisticated epistemological standpoint, which has been linked to stronger performance in formal educational settings (Muis, 2007).

In consideration of the second area of future research, assessment of learning gain has recently become a very exciting topic in technology-enhanced learning. Retention figures and formal assessment are no longer sufficient or satisfying means of assessing learning, even in formal learning environments. Especially in the age of open learning, in which learners of various educational, social and economic backgrounds have more accessibility to learning than ever before, it is important to keep such learners motivated and engaged through evaluating their progress (gains over time) and not their products (formal assessments, completion of degrees). For non-formal learning, this is especially important as learning gains may develop over years, especially with regard to personal development and learning skills. Not only would it be very useful for the community of practitioners in non-formal education to have some milestones along the way that would indicate learning, it is also important for developing basic skills in learning to learn. In the European Union's Erasmus + programme, which manages a budget of EUR 14.7 billion, 'learning to learn' represents one of the 7 key competencies that should be addressed through non-formal learning initiatives seeking funding from the program. That is an enormous investment in learning to learn. Investigation of how to identify, qualify and quantify metacognitive gains represents one promising avenue of educational research to which this study can contribute.

Finally, there is tremendous potential in drawing on such studies for the advancement of research related to self-regulated learning in online environments. Researchers are already developing mechanisms for the automatic detection of self-regulation in online environments. For example, researchers are beginning to utilise the field of learning analytics to leverage trace data for understanding students' self-regulatory behaviours (Winne and Perry, 2000; Hadwin et al., 2007), to conduct interaction analysis for self-regulated learning (Dettori and Persico, 2008) and to identify a learner's knowledge base through expressed competencies (Steiner and Albert, 2011). In combination with recent work to detect reflection in online environments (Ullmann, Wild and Scott, 2013; Ullmann, 2015), it would be possible to develop adaptive prompts to encourage reflection at the various stages of self-regulated learning. In consideration of the importance of reflection for self-regulation, and self-regulated learning for online learners, we would consider this to be a widely useful development in the field of technology-enhanced learning.

References

- Azevedo, R., Cromley, J.G., Winters, F.I., Moos, D.C. and Greene, J.A. (2005) 'Adaptive human scaffolding facilitates adolescents' self-regulated learning with hypermedia', *Instructional Science*, Vol. 33, Nos. 5–6, pp.381–412.
- Azevedo, R. and Hadwin, A.F. (2005) 'Scaffolding self-regulated learning and metacognition-implications for the design of computer-based scaffolds', *Instructional Science*, Vol. 33, No. 5, pp.367–379.
- Bannert, M. and Mengelkamp, C. (2013) 'Scaffolding hypermedia learning through metacognitive prompts', In *International Handbook of Metacognition and Learning Technologies*, Springer, New York, pp.171–186.
- Boekaerts, M. (1999) 'Self-regulated learning: where we are today', *International Journal of Educational Research*, Vol. 31, No. 6, pp.445–457.
- Boud, D., Keogh, R. and Walker, D. (2013) *Promoting Reflection in Learning A Model*, Vol. 1, Boundaries of Adult Learning, p.32.
- Bruck, P.A., Motiwalla, L. and Foerster, F. (2012) 'Mobile learning with micro-content: a framework and evaluation', *Bled eConference, 25th Bled eConference eDependability: Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future*, pp.17–20.
- Buckingham Shum, S. and Deakin Crick, R. (2012) 'Learning dispositions and transferable competencies: pedagogy, modelling and learning analytics', *2nd International Conference on Learning Analytics & Knowledge*, 29 Apr - 02 May 2012, Vancouver, British Columbia, Canada.
- Chen, C.H. and Bradshaw, A.C. (2007) 'The effect of web-based question prompts on scaffolding knowledge integration and ill-structured problem solving', *Journal of Research on Technology in Education*, Vol. 39, No. 4, pp.359–375.
- Chi, M.T. (2009) 'Active-constructive-interactive: a conceptual framework for differentiating learning activities', *Topics in Cognitive Science*, Vol. 1, No. 1, pp.73–105.
- Colardyn, D. and Bjørnåvold, J. (2004) 'Validation of formal, non-formal and informal learning: policy and practices in EU Member States', *European Journal of Education*, Vol. 39, No. 1, pp.69–89.
- Dabbagh, N. and Kitsantas, A. (2012) 'Personal learning environments, social media, and self-regulated learning: a natural formula for connecting formal and informal learning', *The Internet and Higher Education*, Vol. 15, No. 1, pp.3–8.
- Dettori, G. and Persico, D. (2008) 'Detecting self-regulated learning in online communities by means of interaction analysis', *IEEE Transactions on Learning Technologies*, Vol. 1, No. 1, pp.11–19.
- Fleiss, J.L. (1981) 'The measurement of interrater agreement', *Statistical Methods for Rates and Proportions*, Vol. 2, pp.212–236.
- Fontana, R.P., Milligan, C., Littlejohn, A. and Margaryan, A. (2015) 'Measuring self-regulated learning in the workplace', *International Journal of Training and Development*, Vol. 19, No. 1, pp.32–52.
- Ge, X. and Land, S.M. (2003) 'Scaffolding students' problem-solving processes in an ill-structured task, using question prompts and peer interactions', *Educational Technology Research and Development*, Vol. 51, No. 1, pp.21–38.
- Goggins, S.P., Xing, W., Chen, X., Chen, B. and Wadholm, B. (2015) 'Learning analytics at "small" scale: exploring a complexity-grounded model for assessment automation. *Journal of Universal Computer Science*, Vol. 21, No. 1, pp.66–92.

- Greene, J.A., Muis, K.R. and Pieschl, S. (2010) 'The role of epistemic beliefs in students' self-regulated learning with computer-based learning environments: conceptual and methodological issues', *Educational Psychologist*, Vol. 45, No. 4, pp.245–257.
- Hadwin, A.F., Järvelä, S. and Miller, M. (2011) 'Self-regulated, co-regulated, and socially-shared regulation of learning', In Zimmerman, B.J. and Schunk, D.H. (Eds.): *Handbook of Self-regulation of Learning and Performance*, Routledge, New York, NY, pp.65–84.
- Hadwin, A.F., Nesbit, J.C., Jamieson-Noel, D., Code, J. and Winne, P.H. (2007) 'Examining trace data to explore self-regulated learning', *Metacognition and Learning*, Vol. 2, Nos. 2–3, pp.107–124.
- Hadwin, A. and Oshige, M. (2011) 'Self-regulation, co-regulation, and socially shared regulation: exploring perspectives of social in self-regulated learning theory', *Teachers College Record*, Vol. 113, No. 6, pp.240–264.
- Huang, H.M. (2002) 'Toward constructivism for adult learners in online learning environments', *British Journal of Educational Technology*, Vol. 33, No. 1, pp.27–37.
- Järvelä, S. and Hadwin, A. (2013) 'New frontiers: regulating learning in CSCL', *Educational Psychologist*, Vol. 48, No. 1, pp.25–39.
- Jasinskaja, K. and Karagjosova, E. (2015). Rhetorical Relations. Available at: http://dslc.phil-fak.uni-koeln.de/sites/dslc/katja_files/Jasinskaja_Karagjosova_RR.pdf (access 15 December 2015).
- Kitchner, K.S. (1983) 'Cognition, metacognition, and epistemic cognition', *Human Development*, Vol. 26, No. 4, pp.222–232.
- Kolb, D. (1984) *Experiential Learning*, Prentice Hall, New Jersey.
- Knight, P., Tait, J. and Yorke, M. (2006) 'The professional learning of teachers in higher education', *Studies in Higher Education*, Vol. 31, No. 3, pp.319–339.
- Kravicik, M. and Klamma, R. (2012) 'Supporting self-regulation by personal learning environments', *2012 IEEE 12th International Conference on Advanced Learning Technologies (ICALT)*, Rome, Italy, pp.710–711.
- Ley, T., Cook, J., Dennerlein, S., Kravicik, M., Kunzmann, C., Pata, K., Purma, J., Sandars, J., Santos, P., Schmidt, A., Al-Smadi, M. and Trattner, C. (2014) 'Scaling informal learning at the workplace: a model and four designs from a large scale design based research effort', *British Journal of Educational Technology*, Vol. 45, No. 6, pp.1036–1048.
- Ley, T., Kump, B. and Gerdenitsch, C. (2010) 'Scaffolding self-directed learning with personalized learning goal recommendations', *User Modelling, Adaptation, and Personalization*, Springer, Berlin, Heidelberg, pp.75–86.
- Littlejohn, A., Milligan, C. and Margaryan, A. (2012) 'Charting collective knowledge: supporting self-regulated learning in the workplace', *Journal of Workplace Learning*, Vol. 24, No. 3, pp.226–238.
- Lynch, C., Ashley, K., Aleven, V. and Pinkwart, N. (2006) 'Defining ill-defined domains; a literature survey', *Proceedings of the Workshop on Intelligent Tutoring Systems for Ill-defined Domains at the 8th International Conference on Intelligent Tutoring Systems*, Zhongli, Taiwan, pp.1–10.
- Mezirow, J. (1990) 'How critical reflection triggers transformative learning', in Mezirow, J. and Associates (Eds.): *Fostering Critical Reflection in Adulthood*, Jossey-Bass, San Francisco, pp.1–20.
- McCormick, C.B. (2003) 'Metacognition and learning', *Handbook of Psychology*, Vol. 2, No. 5, pp.79–102.
- McKinnon, S. and Margaryan, A. (2009) Principles of work-related learning. Available at: <http://www.gcu.ac.uk/media/gcalwebv2/academy/content/realworld/Principlesofwrl180909.pdf> (access 2 January 2016).

- McLoughlin, C. and Lee, M.J. (2007) 'Social software and participatory learning: pedagogical choices with technology affordances in the Web 2.0 era', *Proceedings ASCILITE Singapore 2007 ICT: Providing Choices for Learners and Learning*, Singapore, pp.664–675.
- Molenaar, I., Slegers, P. and van Boxtel, C. (2014) 'Metacognitive scaffolding during collaborative learning: a promising combination', *Metacognition and Learning*, Vol. 9, No. 3, pp.309–332.
- Molenaar, I., Van Boxtel, C.A. and Slegers, P.J. (2010) 'The effects of scaffolding metacognitive activities in small groups', *Computers in Human Behavior*, Vol. 26, No. 6, pp.1727–1738.
- Muis, K.R. (2007) 'The role of epistemic beliefs in self-regulated learning', *Educational Psychologist*, Vol. 42, No. 3, pp.173–190.
- Pintrich, P.R. (2004) 'A conceptual framework for assessing motivation and self-regulated learning in college students', *Educational psychology review*, Vol. 16, No. 4, pp.385–407.
- Pintrich, P.R. and De Groot, E.V. (1990) 'Motivational and self-regulated learning components of classroom academic performance', *Journal of Educational Psychology*, Vol. 82, No. 1, p.33.
- Rodgers, C. (2002) Defining reflection: another look at John Dewey and reflective thinking. *The Teachers College Record*, Vol. 104, No. 4, pp.842–866. doi:10.1111/1467-9620.00181
- Schommer, M., Crouse, A. and Rhodes, N. (1992) 'Epistemological beliefs and mathematical text comprehension: believing it is simple does not make it so', *Journal of Educational Psychology*, Vol. 84, No. 4, p.435.
- Schon, D. (1983) *The Reflective Practitioner*, Temple Smith, London.
- Siadaty, M., Gašević, D. and Hatala, M. (2016) 'Associations between technological scaffolding and micro-level processes of self-regulated learning: a workplace study', *Computers in Human Behavior*, Vol. 55, pp.1007–1019.
- Siadaty, M., Gašević, D., Jovanović, J., Pata, K., Milikić, N., Holocher-Ertl, T., Jeremić, Z., Ali, L., Giljanović, A. and Hatala, M. (2012) 'Self-regulated workplace learning: a pedagogical framework and semantic web-based environment', *Journal of Educational Technology & Society*, Vol. 15, No. 4, pp.75–88.
- Simon, H.A. (1977) 'The structure of ill-structured problems', *Models of Discovery*, Springer, Netherlands, pp.304–325.
- Sobral, D.T. (2000) 'An appraisal of medical students' reflection-in-learning', *Medical Education*, Vol. 34, No. 3, pp.182–187.
- Steiner, C.M. and Albert, D. (2011) 'Competence-based knowledge space theory as a framework for intelligent metacognitive scaffolding', in Biswas, G., Bull, S., Kay, J. and Mitrovic, A. (Eds.): *Artificial Intelligence in Education*, Springer, Berlin, Heidelberg, pp.563–565.
- Tough, A. (1979) The Adult's Learning Projects. A Fresh Approach to Theory and Practice in Adult Learning. From <http://ieti.org/tough/books/alp.htm> (access 12 December 2015).
- Ullmann, T., Wild, F. and Scott, P. (2013) 'Reflection - quantifying a rare good', *Workshop: 3rd Workshop on Awareness and Reflection in Technology-enhanced Learning at 8th European Conference on Technology Enhanced Learning: Scaling Up Learning for Sustained Impact*, Paphos, Cyprus, pp.29–40.
- Ullmann, T.D. (2015) 'Keywords of written reflection-a comparison between reflective and descriptive datasets', *CEUR Workshop Proceedings*, Vol. 1465, pp.83–96.
- Van den Boom, G., Paas, F., Van Merriënboer, J.J. and Van Gog, T. (2004) 'Reflection prompts and tutor feedback in a web-based learning environment: effects on students' self-regulated learning competence', *Computers in Human Behavior*, Vol. 20, No. 4, pp.551–567.
- Wesiak, G., Steiner, C.M., Moore, A., Dagger, D., Power, G., Berthold, M., Albert, D. and Conlan, O. (2014) 'Iterative augmentation of a medical training simulator: effects of affective metacognitive scaffolding', *Computers & Education*, Vol. 76, pp.13–29.

- Winne, P.H. (1995) 'Self-regulation is ubiquitous but its forms vary with knowledge', *Educational Psychologist*, Vol. 30, No. 4, pp.223–228.
- Zimmerman, B.J. (1990) 'Self-regulated learning and academic achievement: an overview', *Educational Psychologist*, Vol. 25, No. 1, pp.3–1.
- Zimmerman, B.J. and Schunk, D.H. (Eds.) (2011) *Handbook of Self-regulation of Learning and Performance*, Taylor & Francis, Routledge, New York, NY.

Note

- 1 From <https://www.erasmusplus.org.uk/> (access 15th May 2016).